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Population of Aquatic Warbler in Biebrza Valley in 2024

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Introduction

The Aquatic Warbler *Acrocephalus paludicola* is the only globally endangered bird species in continental Europe. According to data from BirdLife International (2024) and the Aquatic Warbler Conservation Team, it currently nests only in 4 countries – Poland, Ukraine, Belarus and Lithuania. The total population size is estimated at about 18,000-29,000 adults (9,000-13,800 singing males). This range alone shows the uncertainty of the assessment. In addition, the populations in Ukraine and Belarus are currently under limited protection due to the geopolitical situation in the region. The Lithuanian population is estimated at 240 singing males (BEF Lithuania, 2024), the population in Poland is estimated at 4,724 singing males in 2021 (Beuch et al. 2023). The population distribution and numbers makes Poland bearing key responsibility for the future of the Aquatic Warbler population, as the country has the technical capabilities and financing mechanisms (domestic and resulting from membership in the European Union) to protect a large population of the species.

The Aquatic Warbler is protected under Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 (the so-called Birds Directive), as well as under the Convention on the Conservation of Migratory Species of Wild Animals (the so-called Bonn Convention), according to which the Aquatic Warbler Memorandum of Understanding was concluded in Minsk in 2003 and signed by Poland on 13 July 2004. In Poland, the Aquatic Warbler is a protected species and is included on the Polish Red List of Birds with the VU category (vulnerable) (Wilk et al. 2020), similarly on a global scale (Red List Category: VU, BirdLife International 2024). In order to protect the habitats of the Aquatic Warbler in the agricultural landscape in Poland, a dedicated variant of agri-environmental-climatic intervention was prepared for this species (currently implemented on the basis of the Act of 8 February 2023 on the Strategic Plan for the Common Agricultural Policy for 2023-2027 - *Ustawa z dnia 8 lutego 2023 r. o Planie Strategicznym dla Wspólnej Polityki Rolnej na lata 2023-2027*). The species is covered by active protection and habitat conservation projects, conducted, among others, by the Polish Society for the Protection of Birds (OTOP). The Aquatic Warbler is also covered by the species program, Aquatic Warbler Monitoring - MWO as part of the Monitoring of Birds of Poland conducted by the Chief Inspectorate for Environmental Protection. In 1995-1997, 2003, 2009 and 2012, national species censuses were carried out by OTOP, including counting the Aquatic Warbler singing males in the Biebrza Valley.

Aquatic Warbler has high habitat requirements, which results in high sensitivity to environmental changes. In Poland, the preferred habitat is mesotrophic or slightly eutrophic sedge fen mires, well-hydrated, with stagnant shallow water (1-10 cm). In addition, the birds are recorded on floodplain meadows in river valleys with sedges, on calcareous marshes, covered by *Cladium mariscus*, as well as on wet meadows with tall grasses (e.g. *Alopecurus pratensis* and *Phalaris arundinacea*) and tufted sedges. The main threats to the species' breeding habitats are water loss, overgrowth with reeds, shrubs and trees, as well as intensive use, especially mowing during the breeding season.

Aquatic Warbler starts breeding quite late (around mid-May), building a nest on the edge of a sedge clump or on the ground, preferably under an overhang of dry sedge leaves. The nest building, incubation of eggs and care of chicks are done exclusively by the female. A large proportion of females attempts to breed twice a year, in mid-May and in the second half of June (Dyrcz 1993, Tanneberger and Kubacka 2018).

Methods

The 2024 Aquatic Warbler breeding population census in the Biebrza Valley was conducted in compliance with the methodological requirements for inventory and monitoring of this species (Chylarecki et al. 2015, Krogulec and Stasiak 2024). Elements of the methodology of previous Aquatic Warbler censuses were also used to ensure comparability of results and the possibility of assessing changes over the years.

The census unit

The census unit was a singing male. Relatively easy detection during the peak activity time of the breeding season and the possibility of identification of the species based on song make this a standard approach in both monitoring and censuses of Aquatic Warbler. It allows for control over large areas, with the participation of people with even little experience with this particular species (which is quite difficult to obtain due to its rarity and habitat preferences).

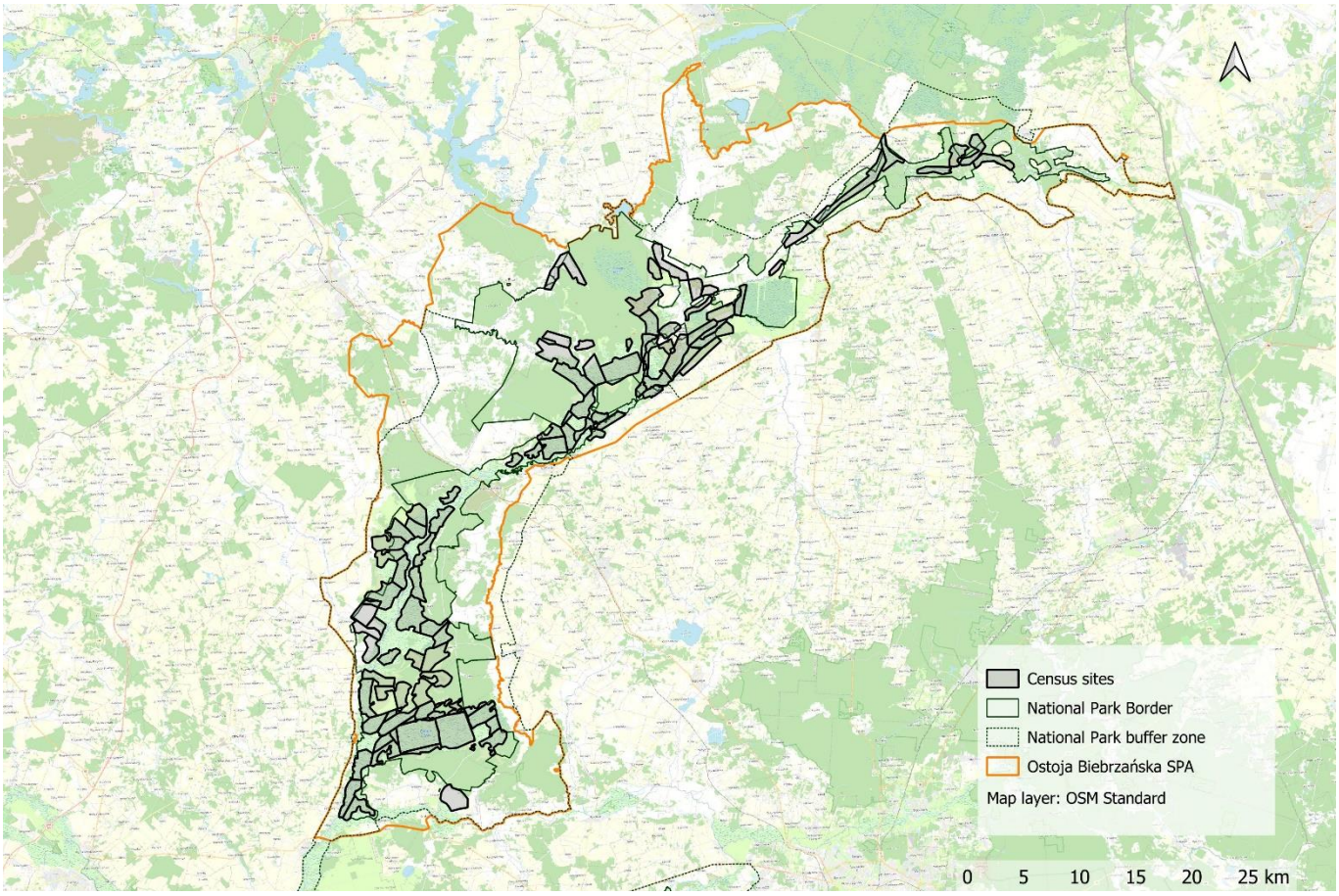
Area of the research

The counts covered all known habitats of the Aquatic Warbler in the Biebrza National Park (BbPN) and its buffer zone, currently or historically occupied by the species, as well as those for which there is no historical data, but which met the habitat requirements of the Aquatic Warbler. From the south, the census boundary was the mouth of Biebrza to Narew river, the counts covered the estuary area and the species site in Zajki marsh in the buffer zone of BbPN. The eastern, northern and western limits of the counting range were the edge of the suitable habitats. The geomorphological division of the Biebrza valley into 3 units, the so-called Basins, was taken from the data of Biebrzański NP. In the Lower Biebrza Basin, the focus was primarily on the area of the Ławki Marsh, Batalionowa Łąka, the mires near Gugny village, and on the other side of the river - the part from Klimaszewnica to Łoje-Awissa villages. In the Middle Biebrza Basin, all habitats on both sides of the river where the occurrence of birds could be expected were checked. In the Upper Biebrza Basin, the work covered fen mires along the riverbed from Nowy Lipsk downstream. The census covered an area of approx. 22,473 ha.

Features of the research areas

At the preparations stage for the census, the area planned to be covered by was divided into research areas of a size that allowed them to be controlled during one evening by a previously determined number of observers (**Map 1**). In 2024, the divisions used during previous censuses were not used. A total of 100 areas were designated with an area from 35 to approx. 870 ha and a passage length of approx. 1500-3500 m, depending on the size of the patch and the structure of the habitat. The largest areas were designated in Bagno Ławki marsh. Within each census area, the control of which was to be carried out by more than two observers, passage routes (census transects) were designated for all observers. They were parallel to each other, at a distance of approx. 100 m in areas with higher densities of Aquatic Warblers, and in areas with lower bird densities, with good visibility, the distances were increased, up to a maximum of 200 m, with accuracy to the shape of the habitat (in particular to the forest edge). In the case of increasing distances between the passage routes, experienced observers were assigned to counting.

Both the research areas and the passage routes had unique numbering, allowing for their identification. The determination of the census areas and transects was carried out in several stages, taking into account consultations with experts in monitoring the Aquatic Warbler working on a daily basis in the particular regions of the Biebrza Valley, including the Biebrza National Park staff. A strategy for reaching individual areas (especially those requiring a long drive or walking and returning) was also prepared, bearing in mind that it would take place after dusk.



Map 1. Distribution of census areas in the Biebrza valley.

Strategy of moving around the areas and recording results

The arrival at the census site and reaching starting points by observers was planned in a way that ensured all counting persons reached their positions before the counting start. Each person was provided in advance with the electronic version of the boundaries of the areas and the passage routes. Each time, during a briefing conducted by the Field Work Coordinator, observers familiarized themselves with the passage routes assigned to them, received complete information on the terrain conditions, the method of reaching the site, the transects and return, the start time and important technical details.

During the census, two equivalent methods of presenting the boundaries of the site and the passage routes and of recording the results were used (at the observer's choice):

- QField application (https://qfield.org) – a free geoinformation tool for mobile devices (Android and iOS) cooperating with the free QGIS environment. In this case, before starting fieldwork, each observer received an individual project to be implemented on their smartphone, containing digital layers with area boundaries, passage routes and a basemap layer, as well as a layer for recording Aquatic Warbler observations. During fieldwork, it was possible to remain offline. The results were sent to the Census Coordinator after each control by e-mail or via an internet communicator (at the basecamp Internet access was provided);

- GPS devices (Garmin®) – observers' own equipment or devices provided by OTOP. Layers with the census sites' boundaries and transects were provided in the form of GPX files. Observers marked the findings in the devices, and after each control they sent the results in the form of GPX files by e-mail or provided the devices to the Census Coordinator to download the files directly at the basecamp.

If necessary, observers could be provided with paper maps, but in practice they were only used during the briefing before going out into the field.

Fieldwork

The field controls were carried out during the first breeding period of the Aquatic Warbler, at the time of the highest activity of singing males. For the purposes of the national monitoring of the Aquatic Warbler in Poland, the cut-off dates for the Aquatic Warbler checks are 20th May to 10th June. Due to the high development of vegetation in the 2024 season, the census counting of Aquatic Warbler began earlier, i.e. on 17th May. The checks were carried out until 10th June, with the greatest intensity of work between 25th May and 3rd June. The counting in the field began approx. 1 hour before sunset and ended no later than 1 hour after sunset. At this time, the greatest activity of Aquatic Warbler singing males is observed and it is assumed that all birds present in the habitat sing simultaneously.

Depending on the size of the census area, the checks were conducted by one person or by teams of observers. The observers moved on foot. In the case of one-person checks, the observer controlled all the appropriate habitats within the area. During team controls, the observers lined up in a skirmish line at one of the edges of the area and then moved parallel to each other along their assigned transects, recording birds on one side of their route. The exception was a person walking on the edge of the skirmish line on the side opposite to the counting side, who recorded birds on both sides of his passage route. The areas were checked once, unless for some reason the check could not be completed or the conditions during the work caused a risk of erroneous results. In such a situation, the count was repeated.

Results processing

The data sent by the observers were compiled in digital form in the QGIS program (https://www.qgis.org). The initial analysis included checking the correctness and completeness of the data, unification in terms of the reference system of the layers. The data was anonymized.

Cross-validation of raw data was performed to remove overlapping records (multiple records of the same individual by different observers). In the first stage of verification, all records were surrounded by a 25 m buffer

(ca. 0,2 ha) and a 100 m buffer (3,14 ha) and neighbouring records within the buffers were analysed. Multiple records of singing males within the 25 m buffer from different observers were reduced to 1. In the case of records from the same observer, verification was based on consultation with that person and expert assessment of the result based on knowledge of the area. Then, expert verification of the distribution of records in the entire study area was performed with the participation of people with many years of experience in monitoring the Aquatic Warbler and its habitats in the given locations. The results were compared to the current knowledge about the state of habitats and to the map layers – orthophotos and current satellite images (publicly available Copernicus data - https://www.copernicus.eu). The aim of this stage was to correct obvious errors such as marking the finding in a forest, outside the habitat area, etc. In doubtful situations, the given finding was interpreted in favour of the species, i.e. it was left as marked.

The census team

Aquatic Warbler Census 2024 Coordinator: Krzysztof Stasiak (OTOP)

Field Work Coordinator: Rafał Szczęch (OTOP, *Ecoekspertyzy*)

Support in the organization of work in the Middle Basin and the Upper Basin of Biebrza: Agnieszka Grajewska (*AwiEkspertyzy*), Piotr Marczakiewicz (Biebrzański National Park)

The team of observers also included 17 people with extensive experience in conducting ornithological inventories and monitoring the Aquatic Warbler. These people were responsible for conducting individual controls in small census areas, and in the case of team controls, also for leading teams of volunteers and supervising the proper course of fieldwork.

The census was attended by 36 volunteers recruited from among members of OTOP, OTOP Local Groups and ornithological clubs at universities. They took part in team surveys, they did not perform individual inspections. These people had previous field and ornithological experience, and at the beginning of their work within the census they participated in the field training in counting the Aquatic Warbler.

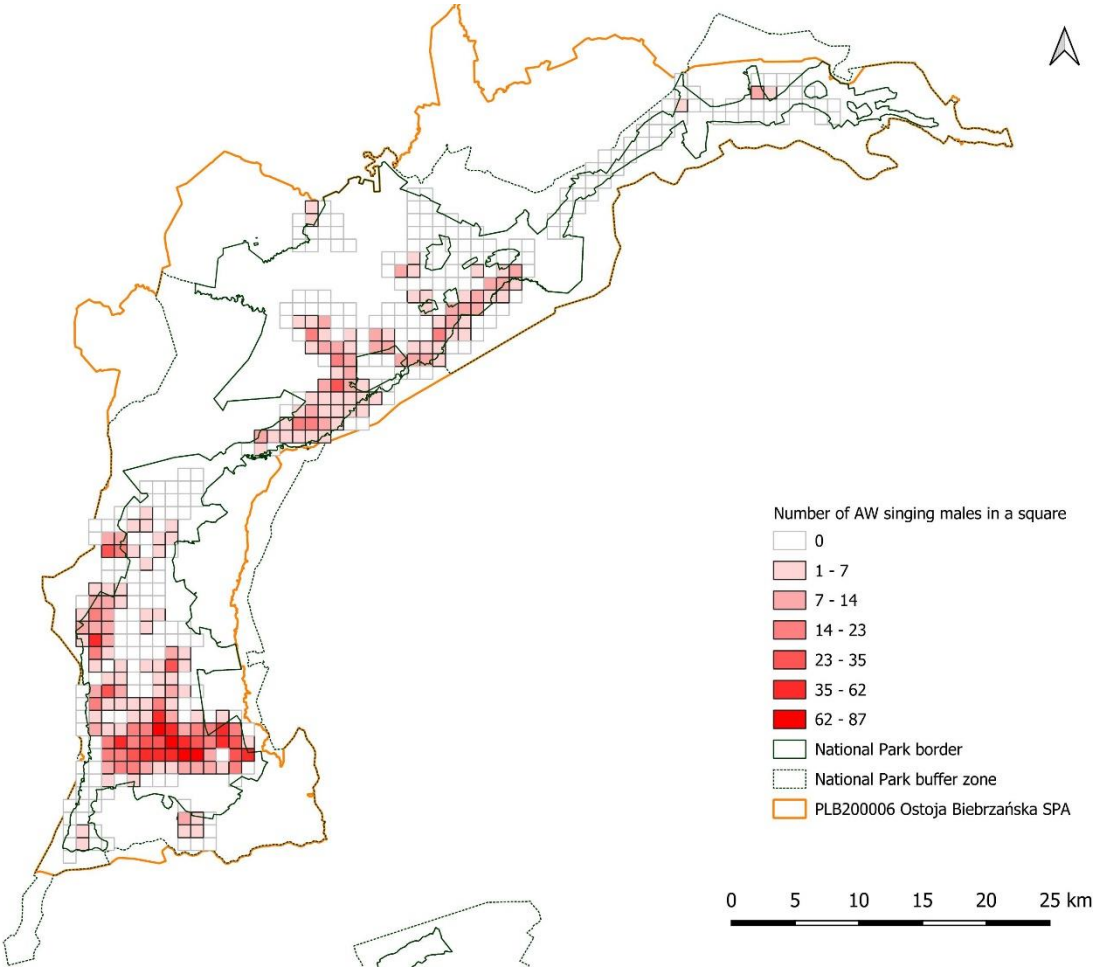
Results

Number and density

During the 2024 census, 2411 Aquatic Warbler singing males were recorded in the census area.

The maximum density of singing males of the Aquatic Warbler was about 87 individuals per 100 ha, but the densities were usually lower. Estimation using a grid of 100 ha squares gave an average density of 4,99 males per 100 ha when taking into account all squares within the census (including those where no birds were recorded) and 11,87 males per 100 ha when taking into account only squares where Aquatic Warbler was recorded. (**Map 2**). Singing males of the Aquatic Warbler were recorded in 73 out of 100 census sites.

Analysing the obtained data in the context of historical censuses of the Aquatic Warbler in this area, it was found that the population of the species in the Biebrza Valley has been quite stable over the last almost 30 years (**Table 1**). In subsequent censuses, starting from 1995-1997 until the current count, results of over 2,000 singing males were obtained, while in studies after 2000 this number oscillated around 2,500 males. Data provided by the General Directorate for Environmental Protection in the Standard Data Form (SDF) for Natura 2000 PLB200006 Ostoja Biebrzańska SPA estimate the Aquatic Warbler population within the area at 2,528-2,742 singing males. The cited data and results obtained in the 2024 season confirm that the area of the Biebrza Valley (currently within the boundaries of the Ostoja Biebrzańska SPA) is one of the most important Aquatic Warbler refuges in the world, crucial from the point of view of the conservation of the species.



Map 2. The occurrence of the Aquatic Warbler in the study area in 100 ha squares.

The results obtained in 2024 allow us to estimate the population size of the Aquatic Warbler in the study area as stable over many years, but subject to short-term fluctuations (**Table 1, Fig. 1**). The trend in the population size of the Aquatic Warbler in Poland in 2011-2023, determined based on the monitoring of this species in the three most important refuges in Poland (Biebrza Valley, Poleski National Park and Chełm Calcareous Marshes) is currently a moderate decline (GIOŚ, 2023). The direction of this decline is primarily due to the most numerous

Biebrza population. At the same time, the monitoring results show that in the period between the Aquatic Warbler censuses in 2012 and 2024, there was a temporary, significant increase in the population of this species in the Biebrza Valley (in 2014-2016).

Table 1. Changes in the population of the Aquatic Warbler in the Biebrza Valley in the years 1995-2024 based on the conducted census of the species.

Year	Source[1]	Number of singing males
1995-1997	OTOP	2041-2082
2003	OTOP	2693-2726
2007	OTOP	2136
2009	OTOP	2528
2012	OTOP	2671
2024	OTOP	2411

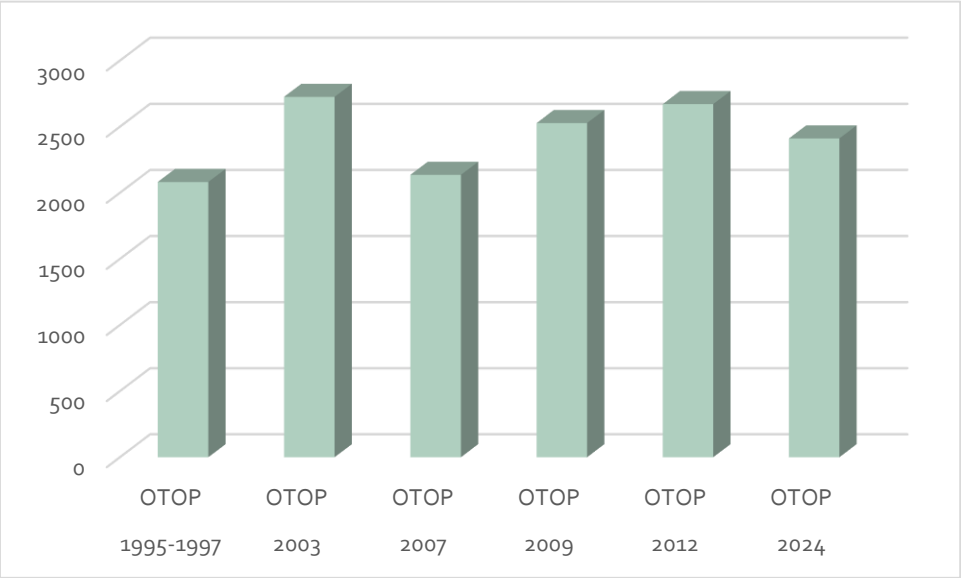


Figure. 1. Changes in the number of Aquatic Warblers in subsequent counts in the Biebrza Valley

Due to the fact that each of the Aquatic Warbler inventories was conducted with the participation of a large research team, which included volunteers, including people with no previous experience in monitoring this species, when assessing the results, it is necessary to take into account the possible, but difficult to estimate, observer error. However, due to the fact that the work was conducted each time according to a similar methodology, this error should not significantly affect the possibility of comparing the results of individual censuses.

Ławki Marsh (Bagno Ławki marsh)

The most important breeding area of the species in Poland and one of the most important in the world, constituting one of the pillars of the survival of the world population in the long term, is the complex of fen mires

[1] Detailed source citations can be found in the *Literature* section.

on the Ławki Marsh and in its immediate vicinity in the Lower Biebrza Basin, almost entirely protected within Biebrza National Park. Within the boundaries of the complex, three main parts should be distinguished, separated by habitat barriers. The main part of Ławki Marsh is the central part of the area. From the north, the habitat is bordered by a long drainage ditch originating in the forest surrounding Laskowe Łąki and initially running parallel to the Honczarowska Causeway with an azimuth of approx. 230 degrees, and then turning towards the river in the west. The western boundary of the habitat is a meridional strip of forest on low elevations along Biebrza river bed, from the south the border is Ols Laskowiecki forest. From the east, the Ławki Marsh is limited by Carska Droga road running on an embankment. This area is covered by a relatively coherent habitat, which, if properly managed, supports reaching the maximum densities of Aquatic Warbler.

Table 2. The number of Aquatic Warbler singing males in the Bagna Ławki complex

Year	Data source[2]	Number
1995	OTOP	822
2003	OTOP	1520
2005	OTOP	2017
2007	OTOP	1332
2008	OTOP	1610
2009	OTOP	1602
2010	OTOP	2141
2011	OTOP	1498
2012	OTOP	1992
2013	OTOP	2066
2014	OTOP	2037
2024	OTOP	1382

The second part of the complex, separated by the formerly described ditch limiting Bagno Ławki habitat from the north, is the Pogorzałe, Batalionowa Łąka and the so-called Grzybek marshes, which maintain connectivity both with each other and with the main patch of Bagno Ławki habitat. In this part of the complex, the Aquatic Warbler reached locally very high densities, but with very high variability noted, resulting primarily from the structure of land use.

The third fragment of the habitat complex is the so-called Małe Ławki marsh, located on the eastern side of Carska Droga road and bordered on the other sides by forest complexes on the edges of the fen mire. Apart from a small fragment in the northern part of the area (OTOP Szorce Social Reserve), the entire Małe Ławki marsh is located within the borders of Biebrza National Park.

[2] Detailed source citations can be found in the *Literature* section.

The number of Aquatic Warblers in the Ławki Marsh has been quite variable over the years (**Table 2, Fig. 2**). In the years when counts were conducted in the entire Biebrza Valley, this variability was proportional to the total number of males in this area. The count results in 2024 are among the lowest, comparable to the result from 2007, while the total census result was much higher. This means that a larger number of birds was recorded in other areas of the Valley. Factors that could have influenced this include, on the one hand, the appropriate quality of habitats in these areas, providing the Aquatic Warbler with nesting conditions, and on the other hand, unfavourable habitat conditions in some parts of Ławki Marsh, resulting in a reduced capacity of this habitat. This is also reflected in the varied density of the Aquatic Aarbler population and its disappearance in some parts of the discussed area (**Fig. 4**).

During the period when the counting of the Aquatic Warbler in the Ławki Marsh took place annually (2007-2014), significant variability of its occurrence was noted in individual years. A clear decrease in the number of singing Aquatic Warbler males between that period and the census in 2024 was particularly visible in several locations. In the strip at the southern border of the area (beside Grąd Laskowiecki forest), especially in its central part (east of Łuczane), the habitat has largely disappeared due to the expansion of trees and shrubs. A similar situation occurred in the area of Pogorzałe, where the expansion of reeds and shrubs is noted. Significantly lower Aquatic Warbler densities than during previous counts were noted in the strip west of Carska Droga and in the north-eastern part of the Ławki Marsh. This is described in more detail in the *Threats* section of this report.

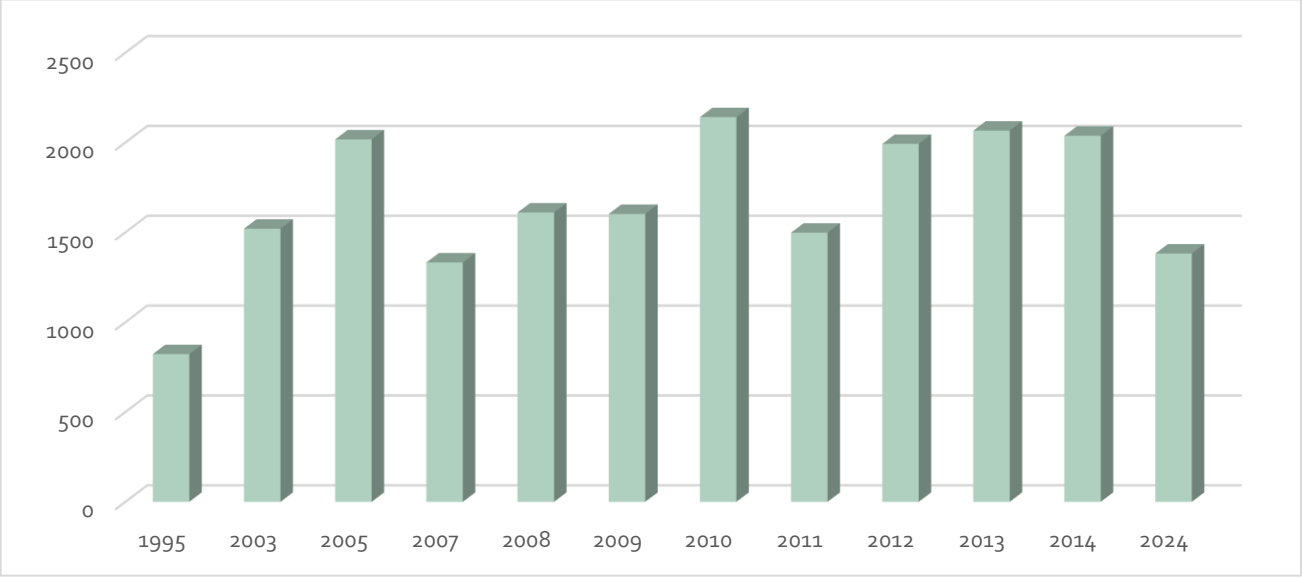
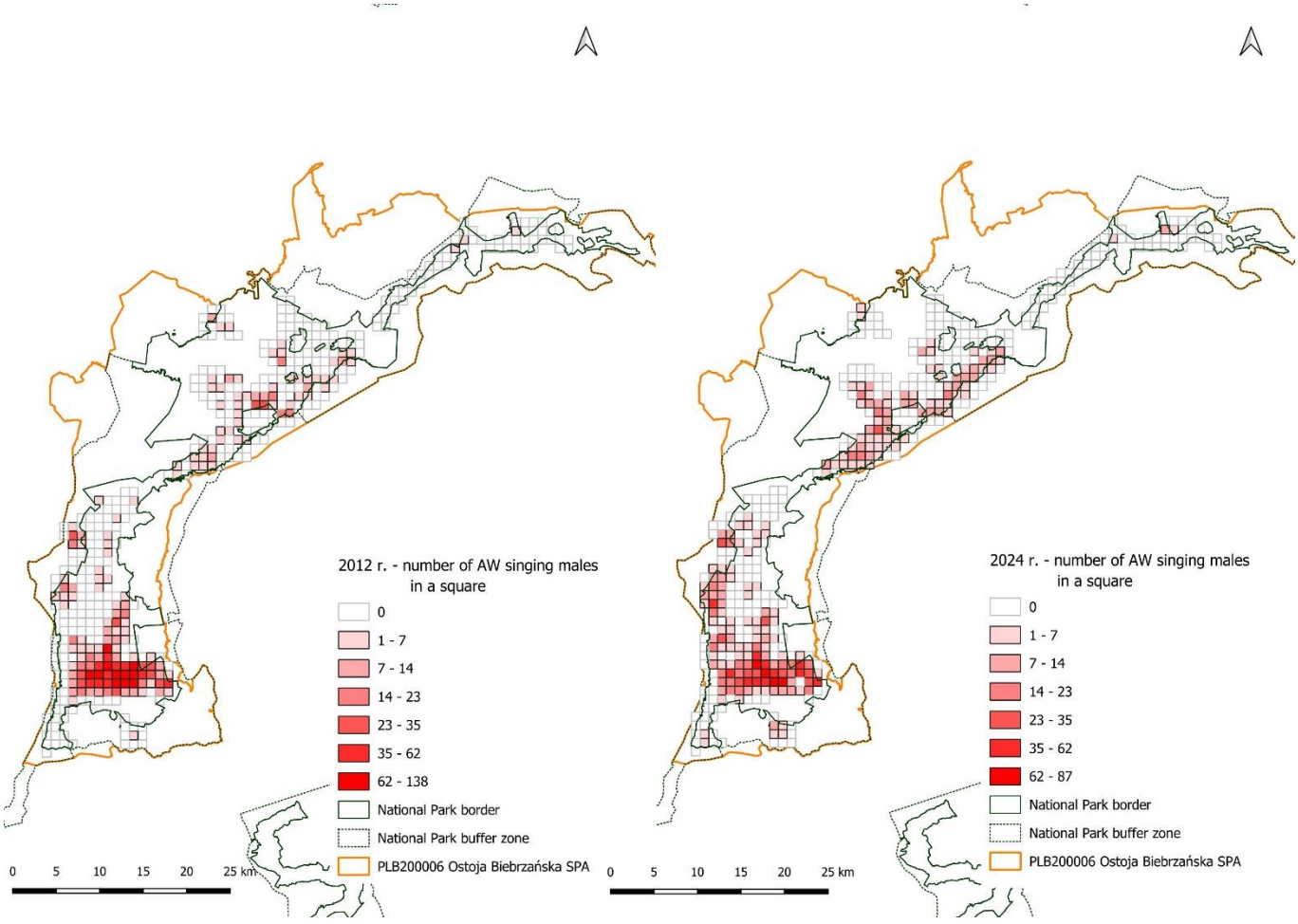


Figure 2. Number of Aquatic Warbler singing males at Bagno Ławki complex

Range

Aquatic Warbler singing males were recorded in 74 out of 100 census plots. After plotting the results on a 1x1 km grid, at least 1 record was found in 202 squares. A maximum of 87 males were recorded in one square. The main areas of bird occurrence included suitable habitats on Bagno Ławki marsh and the adjacent Batalionowa Łąka, the birds were also recorded in large numbers on the so-called Małe Ławki (excluding central part - Czarna Brzezina), in the vicinity of Łoje-Awissa, Mścichy, Goniądz, in the Ełk and Dybła valleys, as well as in suitably used meadows in the part of the Biebrza valley from Karpowicze to Dolistowo Nowe. Smaller concentrations of birds were also recorded in other regions of the valley.



Map 3. Changes in the occurrence of the Aquatic Warbler in Ostoja Biebrzańska SPA in 2012 and 2024

Comparing these results with the data from 2012 (**Map 3**) in the Lower Biebrza Basin, lower numbers and densities were noted in the Ławki Marsh, especially in its overgrowing parts. A smaller range of the Aquatic Warbler was also noted in the fen mires near Gugny village. However, Aquatic Warblers were observed in the strip of riverside meadows and mires on the eastern bank of Biebrza north of the Honczarowska Causeway, where they were not recorded in 2012. The range of the species and its numbers increased significantly on the western bank of Biebrza,

in the meadows and fen mires near Łoje-Awissa village, where in 2012 only a small, concentrated population existed. The occurrence of the Aquatic Warbler in the vicinity of Mścichy village remained at a similar level.

In the Central Biebrza Basin, there have been clear changes between subsequent inventories. In 2012, the main habitat of the Aquatic Warbler was a vast marsh between the Wroceński Forest and Grzędy. In addition, the birds were recorded in smaller numbers in the vicinity of Dolistowo and Kopytkowo. In 2024, a partial disappearance of suitable habitat was noted on the marsh north of the Wroceński Forest, while moderately numerous populations of the Aquatic Warbler were recorded in the Ełk, Dybła and Brzozówka valleys, where a large area of good quality habitats was confirmed.

In the Upper Biebrza Basin, both during the 2012 and 2024 census, single males of the species were recorded singing in the most extensive patches of suitable habitat. This part of the Natura 2000 area is of lesser importance for the Aquatic Warbler.

According to telemetry data (Schaeffer et al. 2000), the average individual home range of a male Aquatic Warbler during the breeding season was 4.6 ha. According to available data and our own observations, the home ranges of neighbouring males may overlap. Based on these data, the home ranges occupied by singing Aquatic Warbler males in 2012 and 2024 were compared. Each of the observations was surrounded by a circular buffer of 4,6 ha (radius 121 m), and overlapping buffers were aggregated. The total area occupied by the birds in 2012 was 4613,15 ha with a population of 2594 males and a maximum density of 138 males per 100 ha. In 2024, a larger occupied area was recorded, amounting to 5347,11 ha (an increase of almost 734 ha), with a population of 2411 males and a maximum density of 87 males per 100 ha. This means an increase in the species' range by 15.9% compared to the state in 2012, but with a decrease in population by over 180 individuals (7% of the population in 2012) and a decrease in the maximum density by 37%.

Habitat of occurrence

All open patches of well-moistened (wet) permanent grasslands were considered as the potential habitat of the Aquatic Warbler.

The highest densities were recorded on extensive, mesotrophic fen mires covered with sedge with well-developed clumps of vegetation and a mosaic of patches mown 1, 2, 3, or possibly approx. 4 years earlier (it was not always possible to precisely determine this). The 2024 season was dry, which led to drying out of most of the area - almost no stagnant water was observed on the ground surface or between clumps. The occurrence of willow undergrowth, sometimes birch or black alder, was recorded on many census plots. Their occurrence is not favourable for the Aquatic Warbler, even if males were observed singing from willow shrubs. Apart from Batalionowa Łąka, such a habitat structure was not conducive to high bird densities. Batalionowa Łąka is characterized by high numbers of Aquatic Warblers, also recorded during the annual monitoring of this species, which is most likely due to a whole set of habitat factors. In the scale of the entire range of Aquatic Warbler in the census area, the overgrowth of willow or other species of shrubs and trees was a factor limiting the occurrence of birds, up to their complete absence if the bushes reached a high density, an estimated height of over approx. 1.8-2.0 m and denseness. This also concerned the occurrence of strips of shrubs along ditches or streams. Such linear structures cause habitat

fragmentation and were avoided by the Aquatic Warblers, both the stripes themselves and their close vicinity **(Fig. 3)**.

The factors causing the loss of habitat and the lack of records of the Aquatic Warbler were also the patches of shrubs or trees and the occurrence of patches of reed. Within the Ławki Marsh, Aquatic Warblers were not recorded in the part adjacent to Biebrza, separated from the main fen mire by a strip of forest and covered with a mosaic of reed beds, oxbow lakes and meadows located on small elevations.

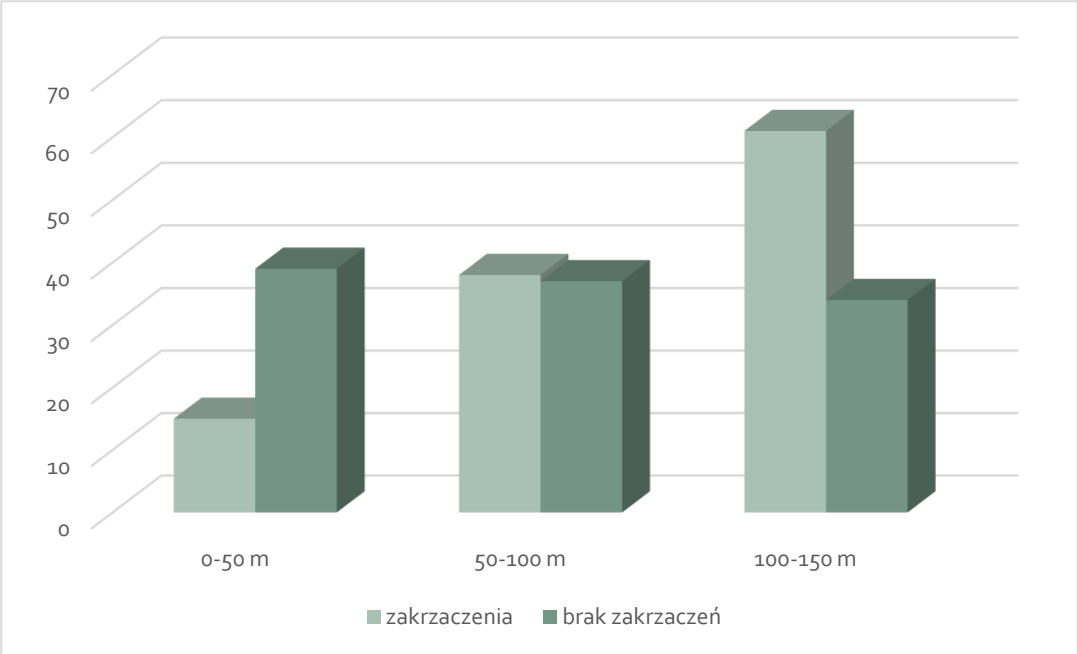


Figure 3. Number of male Aquatic Warblers recorded singing at a specific distance from a ditch covered by shrubs and ditch without shrubs on Ławki Marsh (shrub ditches – 11199 m, no-shrub ditches – 6805 m)

Another habitat type preferred by the Aquatic Warbler were meadows with a large share of sedges, mowed once or twice a year (counting took place before the first cut in two-cut use). This was observed mostly at the western bank of Biebrza near Łoje-Awissa, where a larger number of birds was recorded in 2024 than in 2012. The birds occupied habitat patches characterized by proper moisture – water at least squeezing out of the substrate when pressed, or a shallow, several-centimetre layer of water on the ground. In case of some of these meadows, where the first cut is made early (e.g. from June 15, in accordance with the requirements of variant 4.8 of the agri-environmental-climatic intervention or even earlier), such habitats may create an ecological trap for the Aquatic Warbler if the late start of the breeding season for this species coincides with the earliest possible mowing date. The actual level of threat should be assessed on the basis of more detailed monitoring of these habitats in terms of the occurrence and nesting of the Aquatic Warbler.

In the Central Biebrza basin, the preferred habitats of the Aquatic Warbler included fen mires and meadows on peat characterized by adequate hydration, lack or a small amount of shrubs and reeds. The increase in the range and numbers of the Aquatic Warbler in this part of the Biebrza National Park was probably caused by the appropriate measures, which included initial mowing and then regular mowing in the mosaic of patches mown

in subsequent years, among others as part of variant 4.9 of the agri-environmental-climatic intervention (dedicated for Aquatic Warbler). The actions undertaken there are a very good example of proper habitat management beneficial for the species. The highest densities of the Aquatic Warbler were recorded there on the largest uniform patches of the habitat. The main limiters of the species occurrence observed in the field were the water level and the occurrence of tall vegetation (trees, shrubs, reed bed). Other habitat features seem to be of lesser importance in this case. The most important site of the species recorded in this area during the count in 2012, located between the Wroceński Forest and Grzędy, in 2024 was occupied at a significantly smaller area due to overgrowth with vegetation unfavourable for the Aquatic Warbler. The birds also withdrew from the eastern part of this site, despite favourable habitat conditions (assessed using the expert method). The Aquatic Warblers left this area after the fire in 2020 and, unlike other sites, did not reoccupy it after the vegetation had been restored, which may be related to the effects of the fire. The causes of this phenomenon have not been fully explained and require further research. In addition, good habitat conditions and relatively high male densities were recorded in the valley and around the mouth of Brzozówka river to Biebrza. These results are similar to the previous census. The species' numbers and range in the fen mires north of Kopytkowo decreased.

In the Upper Biebrza basin, the Aquatic Warbler occurred on more extensive patches of marshes near Nowy Lipsk, and avoided long and narrow strips along the riverbed. The number of males recorded was higher than in 2012. The Aquatic Warbler census did not include monitoring of the estuary of the Sidra valley, which is covered by the national Aquatic Warbler monitoring. In the 2024 season, inspections in this area revealed one singing male.

Treats

The most important threat to Aquatic Warbler in the census area remains water loss and drying of habitat. This is happening both through the existing network of drainage ditches and as a result of climate change. Lower snowfall totals in winter, shorter period of snow cover retention and lower spring rainfall totals require taking action to improve long-term water retention in the valley. Another probable cause of deteriorating water conditions is the intensification of agriculture (including cattle breeding and milk production) in areas adjacent to the valley. In order to properly manage water in the Aquatic Warbler habitats, both local actions are necessary, aimed primarily at slowing down the outflow of water from marshes (including liquidation or cascade damming of existing ditches), as well as analysis of the hydrological cycle in the entire catchment area, taking into account the actual and estimated water intake from the environment. Based on such analysis, some protective actions of the Biebrza ecosystem should be planned at the level of the entire Biebrza catchment.

The second significant threat, still present despite the undertaken protective measures and projects for the Aquatic Warbler and species under its ecological umbrella, is the loss of habitats due to the succession of shrubs, trees and reeds (**Fig. 4**). In relation to the succession of trees and shrubs (especially willow, birch and alder), the contributing factor seems to be the periodic strong drying of the fen mire and high mowing of vegetation. An example of such action was the winter mowing of shrubs in the south-western part of the Ławki Marsh, leaving shoots ("pencils") up to 40-50 cm high. Such an action leads to strong rooting of these species, and then rapid regrowth after cutting. A probably beneficial solution would be the selective grubbing up of these species, regardless of mowing entire areas in the Aquatic Warbler's habitats, with cutting the shoots at ground level (as low

as possible). In combination with the improvement of water conditions, such actions should limit the ability of shrubs to regrow.

Regarding reeds, factors favouring their development are an increase of the habitat trophy (nitrogen-loving species), lack of mowing or very late mowing (winter). In the case of dense reed beds, in order to restore habitats favourable to the Aquatic Warbler, it would be necessary to consider a more intensive use regime than that favourable to the birds in optimal habitats and mow the reeds before they produce seeds.

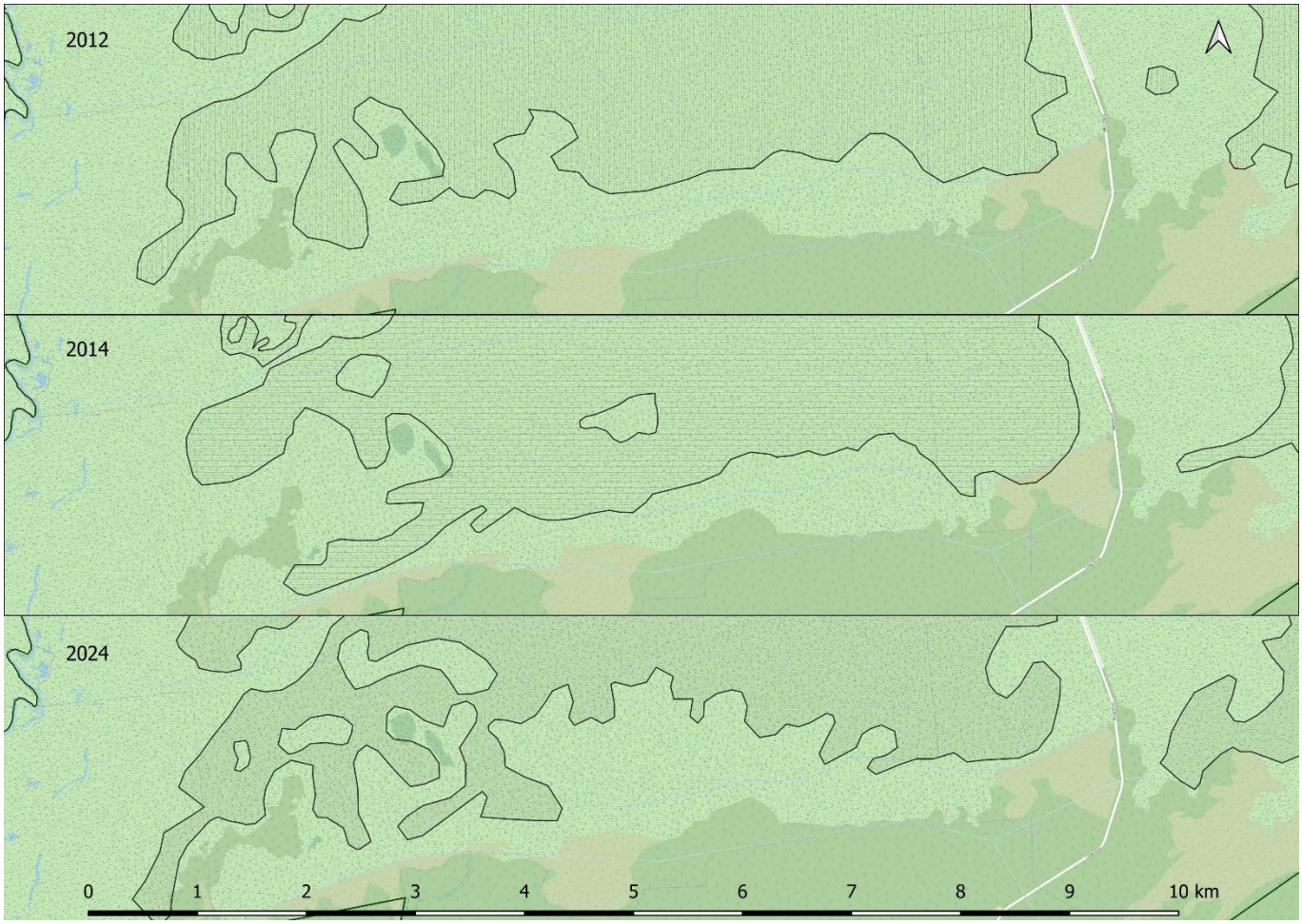


Figure 4. The range of the Aquatic Warbler in the southern part of Ławki Marsh in 2012, 2014 and 2024 – changes due to changes in the habitat.

Another threat observed in many extensively used Aquatic Warbler habitats, not only in the census area, is leaving biomass after mowing, leading to eutrophication of the habitat, and in the case of leaving the biomass in its entirety (cut reeds, shrubs, sedges), also leading to the formation of a cover of dead biomass (felling) limiting the growth of many plant species. Cut osiers and birches left, for example in the south-eastern and southern parts of the Ławki Marsh, affected both the possibility of developing low vegetation and increased fire risk. The removal of cut biomass from Aquatic Warbler habitats should take place immediately after mowing, and this activity is crucial for the proper maintenance of the condition of these habitats.

The population of Aquatic Warbler found in habitats in more intensively used areas, including the western side of Biebrza (around Łoje-Awissa), is exposed to the destruction of nests in the event of early mowing of meadows. In some cases, the first cut was observed there already during the counting, so it should be assumed that all Aquatic Warbler nests that were located on such a plot were destroyed. The solution to this problem should be based on the appropriate provisions of the adopted protection plan for the Biebrza National Park and the adopted plan of protective tasks for the Natura 2000 Ostoja Biebrzańska area. They would constitute a legal basis that should oblige mowing in such areas, which are private property, under ornithological supervision conducted by the National Park (with the participation of employees or subcontractors employed by the park), and the mowing date would be adjusted each time to the phenology of the Aquatic Warbler. This would allow the birds to successfully bring out its first clutch, and mowing could be done before the Aquatic Warbler nests again on a given plot. With this procedure, the risk of creating an ecological trap on early-mown meadows would be minimized and ornithological supervision would allow for the detection of breeding individuals.

Recommendations

Due to the current climate situation, as well as the political context, the location of the Aquatic Warbler in the Natura 2000 Ostoja Biebrzańska area is probably the most important breeding ground for the species within its range of occurrence in the world. For this reason, the habitats of the Aquatic Warbler should be prioritized for conservation measures that are primarily consistent with the requirements of this species. They should be carried out on the largest possible scale and individual measures should be complementary both with each other and, for example, with projects concerning the protection of the species and the general protection of nature in this and neighbouring areas.

The Aquatic Warbler habitats within the boundaries of Natura 2000 Ostoja Biebrzańska are covered by the national Aquatic Warbler monitoring (MWO), which is a Program of Monitoring of Birds of Poland (MPP) consisting of 80 monitoring transects and 4 monitoring sites. The results of the monitoring are collected annually, and on their basis, the population trend of the species in Poland is calculated. Due to the fact that the vast majority of the Aquatic Warbler population in Poland occurs in the census area, the population in the Biebrza Valley has a decisive influence on the direction of this trend. From 2023, it is defined as a moderate decline (GIOŚ 2023). The most important goal of the Aquatic Warbler protection measures in this area should therefore be to stop the decline and then reverse the trend and increase the Aquatic Warbler population.

For the Natura 2000 Ostoja Biebrzańska area, no plan of protective tasks (PZO) has been adopted so far, despite the preparation of detailed documentation approx. 10 years ago. Currently, the draft conservation plan (PO) of the Biebrzański National Park is being processed, which covers all the most important Aquatic Warbler locations in the Ostoja Biebrzańska SPA. The proposed solutions and actions provided for in this draft plan are consistent with the scope of the necessary protection of the species. It is essential to strive to establish the PO of the Biebrzański NP as soon as possible and to start implementing its provisions. Without a legal basis in the form of a local law act, the protection of the Aquatic Warbler is severely limited. It is also necessary to update as a priority the provisions of the draft PZO for Ostoja Biebrzańska SPA covering part of the SPA outside the borders of the Biebrzański NP, and then to complete the formal part and adopt the document. This action should also be considered in the context

of the responsibility of Poland and the Polish Government for the state of the natural environment, and in particular for the most valuable areas and species in the country.

Considering active protection, necessary actions should be taken in the areas where the Aquatic Warbler occurs, including those described in this study in the context of threats to the species. They should include, first of all, preventing water loss and supporting its retention, as well as maintaining existing Aquatic Warbler habitats and restoring the proper condition of habitats that have lost it for various reasons and have been abandoned by the birds. When restoring habitats and designing measures for their maintenance, a landscape approach should be applied, planning a mosaic of actions (especially mowing in different years) on the scale of the entire available habitat patch, thus creating appropriate conditions for the occurrence of both Aquatic Warbler and other bird species with similar habitat requirements. For this purpose, available sources of financing should be used, among others, the variants of agri-environmental-climatic intervention dedicated to the Aquatic Warbler and other species, sources of financing at the national and international level, including funds from the European Union budget (e.g. LIFE fund). The actions taken should be planned and carried out in cooperation with the scientific community, non-governmental organizations experienced in the protection of the Aquatic Warbler (including OTOP) and ornithological experts with extensive field experience in the monitoring of the Aquatic Warbler and its habitats in Ostoja Biebrzańska SPA. Where necessary, detailed guidelines regarding the use regime should be included in the PZO and PO, which provides a legal basis for obtaining financing and implementing actions.

Conclusions

Due to the key importance of the Biebrza Valley for the preservation of the Aquatic Warbler population worldwide, it is necessary to intensify protective measures, mainly consisting in stopping the outflow of water and increasing its retention, as well as counteracting plant succession. Proper protection, use and monitoring of this area should be a priority in the protection of the Aquatic Warbler on a scale of its entire population.

The Aquatic Warbler census conducted in 2024 took place after a long – 12-year break resulting largely from difficulties in obtaining financing for such activities. Although the national monitoring field work instructions contain guidelines for conducting a species census every 5 years, funds for this purpose are not provided. All Aquatic Warbler censuses conducted by OTOP and financed as a part of the implementation of species conservation projects (including 3 projects co-financed from the LIFE fund).

The results of the 2024 Aquatic Warbler census in the Biebrza Valley carry valuable information on the ecology of the species and the state of its most important population in Poland and one of the most important in the world. The collected data will allow for better protection planning and conclusions about the state of the Aquatic Warbler population in the Biebrza Valley. Over the course of all censuses since 1995, we have observed a relative stabilization of the population in terms of numbers in this area - this is very good news. A detailed analysis of the occurrence of Aquatic Warbler in various parts of the area indicates changes in habitats, which result in their occupation or abandonment by birds. On the one hand, we observe the degradation of some areas, mainly caused by drainage and overgrowth due to limited or abandoned use. On the other hand, the undertaken conservation

measures and the restoration of habitats allow them to be reoccupied by birds. This is a very optimistic phenomenon, and the good practices that lead to it should be emphasized and replicated. An important aspect seems to be the increase in the number and range of the Aquatic Warbler in more intensively used meadows, especially on the western bank of Biebrza river, which can be an ecological trap for birds if early mowing leads to the loss of broods or the death of young birds. This area should therefore be given special attention. At this stage, it is difficult to assess the causes and durability of the process of the Aquatic Warbler occupying these areas, but it cannot be ruled out that this will be a permanent phenomenon in the medium and long term. On the scale of the entire area, the most important problem that requires an urgent solution through decisive action is the loss of water, which leads to the drying out of many areas. This has very diverse and multi-directional, negative effects on these ecosystems.

Carrying out the census in such a large area required the involvement of a large number of observers – experienced experts and volunteers. Invaluable help, substantive support and excellent cooperation at every stage of planning and implementation of the work were offered by employees of the Biebrza National Park, including taking an active part in field surveys. Biebrza National Park has recently been the place of implementation of many activities in the field of active protection and environmental monitoring, including during the preparation of the protection plan, monitoring of bird species and habitats and others. One of the effects of this work is the availability of a large group of experienced experts with extensive knowledge of the nature of the park, and what is even more important during the implementation of the census – current, practical knowledge of the area. Their participation in the counting allowed for very efficient arrival and return from the census areas, with minimal impact on the environment. Creating, training, maintaining and engaging in this type of work a team of people with practical experience in the specific area in which the work is carried out should be a common good practice.

The census was conducted based on the permission of the Director of the Biebrza National Park.

Participants

57 observers took part in the 2024 Aquatic Warbler Census:
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